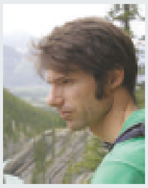
Abstractions



FIRST AUTHOR
When we look at the giant planets through an optical telescope, they seem to be solid masses. In fact, they feature a huge amount of movement — from winds on the surface to magnetic forces emanating from the deep interior. Moritz Heimpel, a physicist at the University of Alberta in Canada, has a long-standing interest in these planetary dynamics. On page 193, he uses a computer model to describe how the winds that form the distinctive bands on Jupiter's surface are powered by forces from within the planet. Heimpel takes time away from his modelling to explain the idea to *Nature*.

Why Jupiter?
I'm interested in the core of Earth and how it generates a magnetic field. We can't directly see what's going on in Earth's core, but if you look at the giant planets, such as Jupiter or Saturn, you can see the fluid dynamics occurring right on the surface. The giant planets provide a natural laboratory for the fluid dynamics of other planetary bodies.

Why this particular problem?
You can look at Jupiter with your telescope and see the bands. This model has to do with explaining how those bands come about and why they are stable.

How does this build on earlier work?
There have been previous models trying to relate how surface flow relates to the deep interior. These worked well for Jupiter's equator. What hasn't been done before is to model how the multiple high-latitude jets come about.

What was the challenge in capturing that phenomenon?
When you think about fluid dynamics on a small scale, you think about things like a creek with little whorls of current. Then you try to scale that up to planetary size. That seems like an impossible task.

How did you manage to scale the model up?
A good computing system and better code. Also, scaling theory for planetary turbulence.

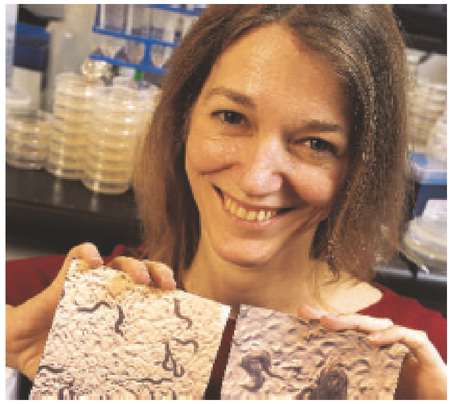
What were the individual contributions from the team members?
Johannes Wicht developed the computer code. He's a physicist at the Max Planck Institute for Solar System Research in Katlenburg-Lindau, Germany. I had some ideas on how to set up the model's parameters. And I worked with Jonathan Aurnou at the University of California, Los Angeles, on scaling issues.

How do you feel about the model now?
It seems kind of nice that you can reproduce some of the main features of the planets. ■

MAKING THE PAPER

Cornelia Bargmann

Building a maze for nematodes offers an insight into learning.



K. CHERNUSH/HHMI

In her bid to gain insight into the complex relationship between learning and behaviour, Cornelia Bargmann opted to keep things simple: she studied the nematode worm *Caenorhabditis elegans* (see page 179).

Earlier research had shown that these worms can learn, but Bargmann, based at Rockefeller University in New York, wanted to know how and why. She knew that worms fed in an environment kept at a particular temperature associated that temperature with food. If they were then placed in another environment, they would head for an area at the same temperature as where they were fed.

To expand the boundaries of what could be studied in the organism, Bargmann decided she needed to "think like a worm". That led her to consider a worm's natural environment: soil. This is teeming with thousands of organisms — mostly bacteria. Some of those bacteria are beneficial to the worms, others can make them sick, or even kill them. "For the worm, this would be something worth learning about," thought Bargmann.

To find out more, she looked at 'conditioning.' Common in many organisms, this form of learning occurs when, for example, an organism eats something with a novel flavour and gets sick shortly afterwards. As a result, the organism forms a strong memory of that flavour and rejects it in the future. The effect can be so strong that one bad taste can be enough to turn an organism away from things associated with that experience.

Bargmann's postdoc, Yun Zhang, did some simple experiments exposing worms to a 'good' strain of bacteria and a 'bad' one. Very quickly, the worms showed some strong preferences. But Bargmann was worried that giving the worms two choices was like giving someone a true/false test; guessing would give a correct answer half the time. She wanted more definitive results, but wasn't quite sure how to produce them.

Fortunately, she had just begun an interdisciplinary project: Bargmann had invited a few engineering postdocs to work with her, although she wasn't yet sure how they would fit in. One of them, Hang Lu, who did microfluidics at the Massachusetts Institute of Technology, took an interest in the worm project.

Lu's work had focused on how single molecules interact in a circuit-like system, and she thought that scaling this idea up could help the group understand the worms' learning behaviour. "Basically, she made a worm maze," Bargmann says.

Lu built a maze to provide statistically significant results. It had eight arms, with four types of bacteria — two malevolent and two benign. One of each kind was a type the worms had been exposed to before and one of each type was new.

The worms' behaviour was very distinctive. "They learned to like the good bacteria," Bargmann says. "But more clearly they avoided the bad bacteria." The next step brought Bargmann to more familiar ground: linking the learning to specific genes and cells. Bargmann says that she now wants to find out how the worms make the associations with good and bad bacteria. This will take her into the world of neuroscience — and no doubt require another interdisciplinary effort. ■

QUANTIFIED RUSSIA

A numerical perspective on *Nature* authors.
The town of Chernogolovka in Russia sits on the shores of two small lakes and is surrounded by forests. But this seemingly isolated place is dominated by science. For one, it is home to the Institute of Microelectronics Technology (IMT). The peaceful atmosphere and close proximity to Moscow make Chernogolovka the perfect place for successful research, says Sergey Dubonos, who works at the IMT.

Although the IMT is predominantly a research institute, it also hosts students working towards a university diploma. Dubonos says this partnership plays a key role in attracting young scientists to Chernogolovka. Dubonos and his colleagues also work closely with groups at the University of Manchester, UK, and on page 197 they report on the electronic properties of graphene, a two-dimensional crystal.

3 authors working in Russia report original research in *Nature* this week.

17 authors working in Russia have reported research in *Nature* this year (total number of contributing authors = 5,013).

7 of this year's submissions to *Nature* came from the Russian Academy of Sciences (total number of submissions = 11,697).

71% of authors based in Russia who have had work published in *Nature* this year work in the physical sciences.

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